TWO CRATER PALEOLAKE SITES THAT MEET PRELIMINARY ENGINEERING CONSTRAINTS FOR THE 2001 ATHENA LANDER MISSION.

R D. Forsythe[1] and C. R. Blackwelder [1], [1]Dept. Geography and Earth Sciences, UNC-Charlotte, Charlotte, NC 28223 (rdforsyt@email.uncc.edu)

We have identified two potential paleolake/closed drainage basins that should meet engineering criteria for the Athena lander. These are unnamed, but for the purposes of discussion, will here be referred to as the White Rock basin site (334.75°W, 07.8°S), and the Evros paleolake site (348.5°W,10°S). The science rational for the two sites are similar, but the two vary somewhat in the science opportunities that are present due to site specific characteristics within each of the prospective landing zones.

Rationale for a Paleolake Site

Any site chosen for the Athena Lander should minimally address the following three areas of inquiry: 1) validation and advancement of the general lithostratigraphic framework for Mars, 2) advancing our knowledge of the ancient Martian hydrosphere, and 3) the search for possible life, or past life, on Mars.

Lander investigations (with the potential for sample return) of the two proposed early Martian lake sites provide a reasonable probability for the discovery of chemical and biological sediments that may have a revolutionary impact. Lake, playa, salina, and sabkha depositional environments are all possible to have existed in the early history of Mars; a period for which evidence leads many to believe that water flowed and ponded on the Martian surface under a warmer and wetter climatic regime. Given the prospects for these environments to have been analogous to the Earth's arid and hyperarid regions, low lying basins would have been relatively poor in clastic inputs, and have had a dominance of chemical (and/or biological) deposits. On earth these basins have carbonate, silicate, or iron mineral accumulations in dilute lakes, and carbonate, sulfate, clorite, and silicate (e.g. zeolites where volcanic glass falls into alkaline lakes) minerals in more saline environments. Each of the two proposed sites has attributes which are consistent with the evaporite basin model, and have prospects for accessible exposures of chemical deposits for sample return. Due to thermodynamic and hydraulic constraints that control precipitation of chemical sediment, studies on these environments provide the greatest potential for objective and quantitative advances in our paleoclimate models for Mars. Return samples of salts would also potentially carry abundant encapsulated gas and fluid inclusions of the ancient Martian hydrosphere and atmosphere.

In many terrestrial evaporite sequences one can also find abundant microfossils (e.g. diatoms). Due to low clastic inputs, biotic remains are often easier to find here than in lucustrine environs dominated by clastic deposition. Water rich environs may have been, in analogy to life on earth, oases that persisted within an otherwise expanding and freezing desert on Mars during the late Noachian to early Hesperian, thus a paleolake site is a logical choice for exobiologic research.

Lastly, each of the two sites are located in regions of the Highlands near the dichotomy boundary and provide sampling opportunities for Noachian to early Hesperian layered regolith. The steep, angle of repose, crater margins have provided, largely by mass wasting processes, a source of clastic input to the basins. The floors are thus a collector of debris representing over 1 kilometer of Highlands' stratigraphy. High resolution images for the White Rock basin show a strataform character to the crater margin regolith.

Possible Hazards

The landing area within the White Rock basin is essentially flat, and most likely underlain by strata laid down down in a liquid state. High resolution images of the marginal areas of the basin indicate the presence of debris flows. Small diameter craters are also found on the floor of the basin. The presence of small craters and debris flows suggest that much of the surface area in the potential landing site is represented by a deflation surface and may therefore be relatively free of appreciable sand and loess deposits. One would thus expect a hypsometry controlled by small impact structures, and clasts of chemically resistent debris and ejecta materials.

An inspection of the high resolution imagery has not yet been performed for the Evros paleolake site to determine the surface characteristics of the landing area. However, like the White Rock basin, the basin floor is largely represented by a flat lying surface underlain presumably by strata laid down in a liquid state. The north and northeast margins of the basin have some uneven ground where, by analogy to the White Rock basin, are likely underlain by colluvium shed from the adjacent basin margins. A potential former ground water sapping front may be present along the east side of the basin. If so it suggests that the adjacent floor of the basin may be a salt-facilitated erosional suface, akin to that seen along some of the African Sabka margins.

Science Opportunities

1) Both sites have basin floors which have undergone some excavation due to later cratering. Thus strata laid down presumably in the presence of water should be available for sampling within each of the landing zones. In White Rock basin there is the additional opportunity to sample White Rock, a hypothetical erosional evaporite remanent within the basin. This inselberg also adds further evidence for deflation within the basin. We can expect lag deposits throughout the area which will be a grab bag of resistent materials younger than the current erosional level in the basin.

2) Both basins will have colluvial fans extending into the landing area, thus providing opportunity to sample surrounding Highlands regolith. In the case of White Rock the surrounding regolith is clearly stratified, and debris fans would contain approximately 1 to 1.5 km of highland stratigraphy.

3) The potential chemical deposits to be found here are: carbonates, sulfates, clorites, and silicates (if volcanic ash fell into the salt lake). The chemical deposits provide thermodynamic constraints on the ancient climate and hydrosphere on Mars; and if returned, would have abundant gas

and fluid inclusions that represent the ancient hydrosphere and atmosphere of Mars.

4) While a long shot, past life could be preserved in these areas in forms analogous to terrestrial lakes/seas with low clastic inputs such as happens with diatomaceous layers or stromatolites. If one wishes to identify past life by fossil evidence, low clastic inputs within the depositional environment are essential to improving the odds. Without the garantee of sample return, improving the odds for locating fossil evidence in the Athena mission becomes a higher priority.

Landing Data for the Two Paleolake Sites

Parameter	White Rock #	Evros Paleolake^*
Elevation	~1 - 1.5 km	~1 - 1.5 km
Center Latitude	07.8° S	-10 ° S
Center Longitude	334.75° W	348.5 °W
Upper Left Latitude of AOI	7° S	9 °S
Upper Left Longitude of AOI	336° W	349.5 °W
Lower Right Latitude of AOI	9° S	11 °S
Lower Right Longitude of AOI	333.5° W	347.5 °W
Radar Reflectivity		
Delay Doppler	.03	in progress
Continuous Wave	.06 +/- .03	“
12.6 cm	.066 +/- .027	“
RMS Slopes		
3.5 cm DD	2° - 10°	“
3.5 cm CW	5° - 10°	“
12.6 cm	~6°	“
Surface Properties		
Bulk Thermal Inertia	5 - 7	5 - 7
Fine Component T.I.	6 - 8	6 - 8
Albedo	.18 - .23	in progress
Red Reflectivity	.09 - .11	“
Violet Reflectivity	.05	“
Red:Violet		
Average and S.D.	10.3 +/- 5.2	“
Range	1 - 20	“
Rock Abundances	2 - 8%	3 - 8 %
Viking Image Resolution		
<50m/pixel		
<50m/pixel		

#Data sources: Pleskot, L.K. and E. D. Miner (1981) Time variability of Martian bolometric albedo, ICARUS, 45, 19-201, Christensen, P. R., (1981) Global albedo variations on Mars: Implications for active aeolian transport, deposition, and erosion. J. Geophys. Res., 93, 7611-7624., Palluconi, F. D. and J.H. Kiefer (1981) Thermal inertia mapping of Mars from 60°N to 60°S, Icarus, 455, 415-426, Christensen, P. R., (1986) The spatial distribution of rocks on Mars, Icarus, 68, 217-238.

^Data sources: Secondary source of the presumed above sources as displayed within: HTTP://mars.jpl.nasa.gov/2001/landingsite.

*the area of this site appears on the JPL webpage of “Regions on Mars that satisfy the Engineering Criteria and have 100 m/pixel or better Viking coverage” (http://mars.jpl.nasa.gov/2001/landingsite/Regions.html)